

EVALUATION AND COMPARISON OF COMPOSITE AND SPLIT-THICKNESS SKIN GRAFTS USING CUTOMETER MPA 580

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SUMMARY. *Background.* In our preliminary experiments we found that composite skin grafts consisting of allogeneic acellular dermis and thin epidermal autologous grafts applied to the excised burn wound in one stage led to better results in terms of viscoelastic properties than autologous split-thickness skin grafts. *Patients and methods.* In ten burn patients we applied composite skin grafts consisting of allogeneic acellular dermis and thin epidermal autologous grafts and followed the quality of the reconstructed skin cover with a special device, Cutometer MPA 580, over a period of four years. *Results.* The cutometric curves demonstrated better viscoelastic properties in composite skin grafts than in conventional split-thickness skin grafts after four years. We found Cutometer MPA 580 to be an advantageous device for the objectification of improved quality of reconstructed skin cover. *Discussion.* Among the various methods the cutometer showed the advantage of being a non-invasive, precise, and objective method of measuring skin's viscoelastic properties. The Vancouver Scar Score is a subjective evaluation of skin viscoelasticity. *Conclusion.* Our prospective clinical study clearly demonstrated that cutometric measurement produced objective results in contrast to clinical evaluation, the Vancouver Scar Score, and other non-quantitative methods. Our hypothesis that composite skin grafts consisting of allogeneic acellular dermis and thin epidermal autologous grafts applied onto the excised burn wound in one stage led to better results in terms of viscoelastic properties than autologous split-thickness skin grafts was fully confirmed.

Keywords: Cutometer MPA 580, cutometric measurement, composite skin grafts, allogeneic acellular dermis

Introduction

Current treatment strategies in intensive care medicine permit survival of patients with burns of more than 80% of the total body surface area (TBSA). This is also the result of better understanding and management of burn shock and early radical excision of necrotic burn skin.

In past decades this led to the problem of the reconstruction of lost or severely damaged human skin.¹ This problem has been resolved through expansion of the patient's own epithelium as a life-saving procedure. Epidermal skin only a few square cm in size can be expanded several thousand times in cell cultures in three or four weeks and can then be used to cover extensive burn wounds. Simple grafting with a thin split-thickness skin graft is still the most frequent method of covering various skin defects, and is standard treatment in deep burns. It is generally accepted that in deep skin defects the absence of dermal tissue results in more scar formation and more scar contraction.² The cosmetic effect is not very good. Reconstructive surgery is often necessary to resolve these problems. The unsatisfactory short- and long-term results with regard

to mechanical stability and scarring require alternatives, and numerous studies have targeted dermal substitutes created on various bases.

For the reconstruction of durable and pliable skin, the renewal of the dermal component is very important. This fact has been recognized and many attempts have been made to resolve the problem.

Our study was designed on the basis of an intra-individual comparison between a combination of dermal substitute with a split-skin graft and a split-skin graft only.³

Besides the Cutometer measurements, scar contraction was objectively measured by means of planimetry. In addition, the same scars were subjected to Vancouver Scar Scale evaluation.⁴

Patients and methods

Between 2005 and 2009, ten patients with hypertrophic scars and deep burns were treated with composite skin grafting.

Consecutive patients were eligible if they were ad-

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Fig. 1 - Burn area.



Fig. 3 - Composite skin graft 5 days after operation.

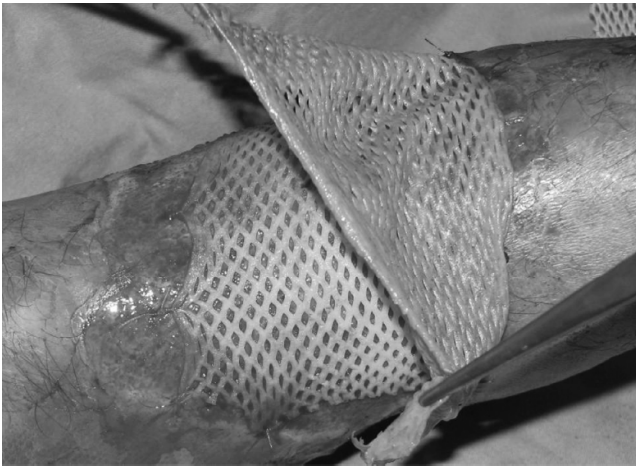


Fig. 2 - Composite skin graft.



Fig. 4 - Composite skin graft 6 months after operation.

mitted to our hospital and needed excision and skin grafting for acute burn wounds or reconstruction of scar tissue that followed the burn injury. The patients provided informed consent before surgery. The conventional treatment of split-skin graft and the experimental treatment (a combination of dermal substitute and a split-thickness skin graft [STSG]) were confined to anatomically related areas to allow a paired intra-individual comparison.⁵ Preferably a right/left comparison was made, but if this was not feasible, a superior/inferior or medial/lateral comparison within one wound surface area was performed.

Surgical procedure

After chemical necrectomy the defect was covered with synthetic dressing material (COM©) impregnated with 2% peracetic acid.

Clean defects were grafted with a meshed STSG and with the composite graft consisting of meshed allogeneic acellular dermis and meshed (1:1.5) thin STSG. The first layer of the composite graft was fixed with an absorbable sewing material - Vicryl© and both skin grafts with metallic clips. On top of the grafts we placed fatty tulle and gauze impregnated with 2% per acetic acid. The staples were removed after 5 to 7 days (*Figs. 1-4*).

Case report

A.S., a male patient, born in 1948, was hospitalized for grade III burns in the dorsum the right leg (2% TBSA). The cleaned defects on the leg were grafted with composite skin graft. Thirty-two days after admission the completely healed patient was discharged with elastic, pliable skin of high quality in the composite graft area (*Fig. 5*).

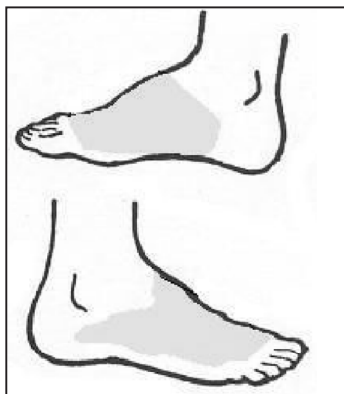


Fig. 5 - Patient A.S., burn area.

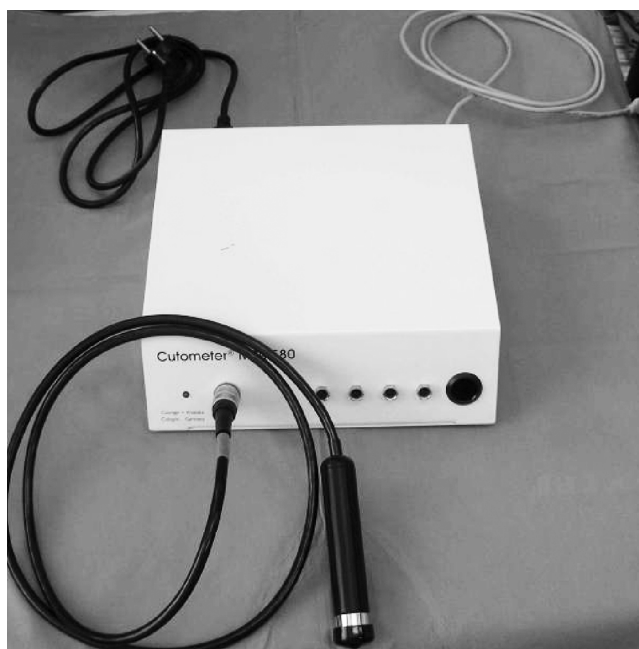


Fig. 6 - Cutometer MPA 580.

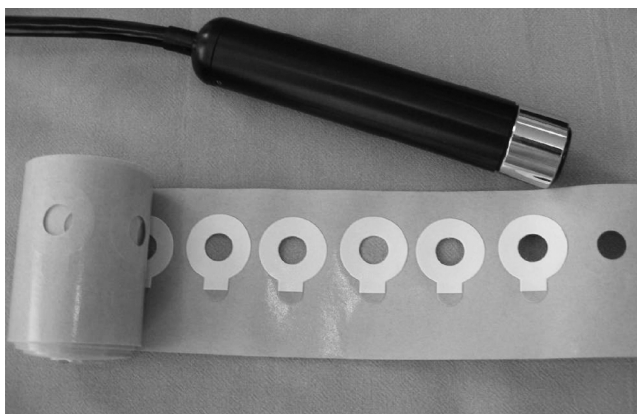


Fig. 7 - Cutometer MPA 580 - probe.

Scar elasticity: The Cutometer

Cutometer MPA 580® (Figs. 6, 7) is used to measure skin viscoelasticity.⁴ The measuring principle is based on skin suction/elongation.^{4,7-9} The device produces negative pressure, adjustable within the range of 20 to 500 mbar. During measurement, a selected point of the skin is drawn into the probe opening by negative pressure. The depth of skin penetration into the opening is immediately determined by a non-contact optical system, consisting of a light source and a receiver. These are two glass prisms, facing each other and leading the light from the transmitter to the receiver. The light beam intensity changes according to the depth of penetration in the skin.

The initial phase - that of skin suction (when the skin is drawn into the probe) is the first part of the curve, shown on the display as the on-time. The duration of this phase may be adjusted within the range of 0.1 to 60 sec.

The second part of the curve represents the relaxation time (off-time). In this phase, the skin returns to its original state and the negative pressure is disconnected.

These two basic parameters portray the skin's ability to return to its original state, thus defining its elastic and plastic properties.

The number of individual measurements may vary. The exact number of repetitions depends on the suction and relaxation times selected. The sum of the suction and relaxation times must not exceed 320 sec (total measurement time).

Another parameter that may be assessed objectively is skin fatigue. Upon its detection, the change of skin properties is recorded during repeated measurements (the speed of skin return to its original shape decreases with repeated suction).

Cutometer MPA 580® allows four different methods of measurement according to the negative pressure applied. The most frequent method of measurement works with constant negative pressure.

During measurement by this method, the skin is drawn into the probe by constant pressure. Subsequently, negative pressure is disconnected and the skin returns to its original shape.

Clinical evaluation of scar tissue: The Vancouver Scar Score

The Vancouver Scar Score is often used for the evaluation of scar quality.¹⁰ We used it for the evaluation of all three types of healed wounds.

Scar assessments were devised based on physical parameters of pigmentation, vascularity, pliability, and scar height. All parameters were assessed independently - the greater the pathological condition, the higher the score.

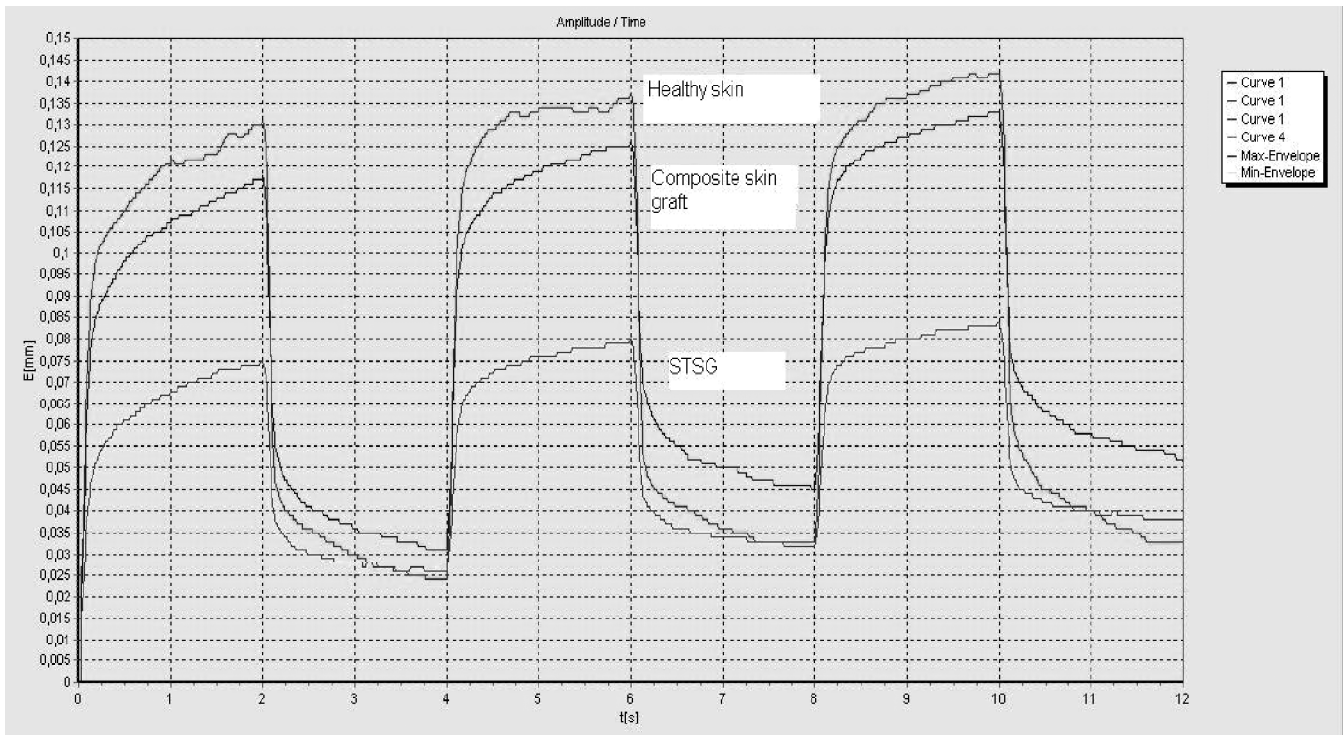


Fig. 8 - Cutometrical curves of healthy skin, composite skin graft, and split-thickness skin graft (STSG).

The x-axis shows the time (sec) behaviour of the measurement.

The y-axis shows the depth (mm) of skin penetration into the probe.

Pigmentation

0 = normal: colour closely resembling that of the rest of the person's body

1 = hypopigmentation = hyperpigmentation

Vascularity

0 = normal: colour closely resembling that of the rest of the person's body

1 = pink

2 = red

3 = purple

Pliability

0 = normal

1 = supple: flexible with minimal resistance

2 = yielding: giving way to pressure

3 = firm: inflexible, not easily moved, resistant to manual pressure

4 = bending: rope-like tissue that blanches with extension of scar

5 = contracture: permanent shortening of scar producing deformity distortion

Height

0 = normal

1 = <2 mm

2 = 3-5 mm

3 = >5 mm

Results

We achieved successful dermal substitution in all patients. The results confirmed our experience of the better quality of the substituted dermis using the method presented than that of standard split-skin grafting. There was no rejection of the recombinant dermal substitute in the group.^{5,11}

The grafts were level with the surrounding healthy skin. Follow-up four years after surgery showed completely integrated allogeneic acellular dermis.¹²

Typical curves defined by the values of R0-R9 parameters are presented. The most important R0 values (maximum height) were as follows: 0.406 on average for healthy skin, 0.12 for grafted areas, and 0.201 and 0.312 for the composite graft.⁷ These data document the significantly better viscoelastic properties of the composite skin grafts than those of conventional split-thickness skin grafts after four years (Figs. 8, 9).

Discussion and conclusion

In our opinion the method described is recommended in grade III burns with complete loss of corium, requiring reconstruction of large hypertrophic scars. The application of this recombinant skin substitute may be useful in acute

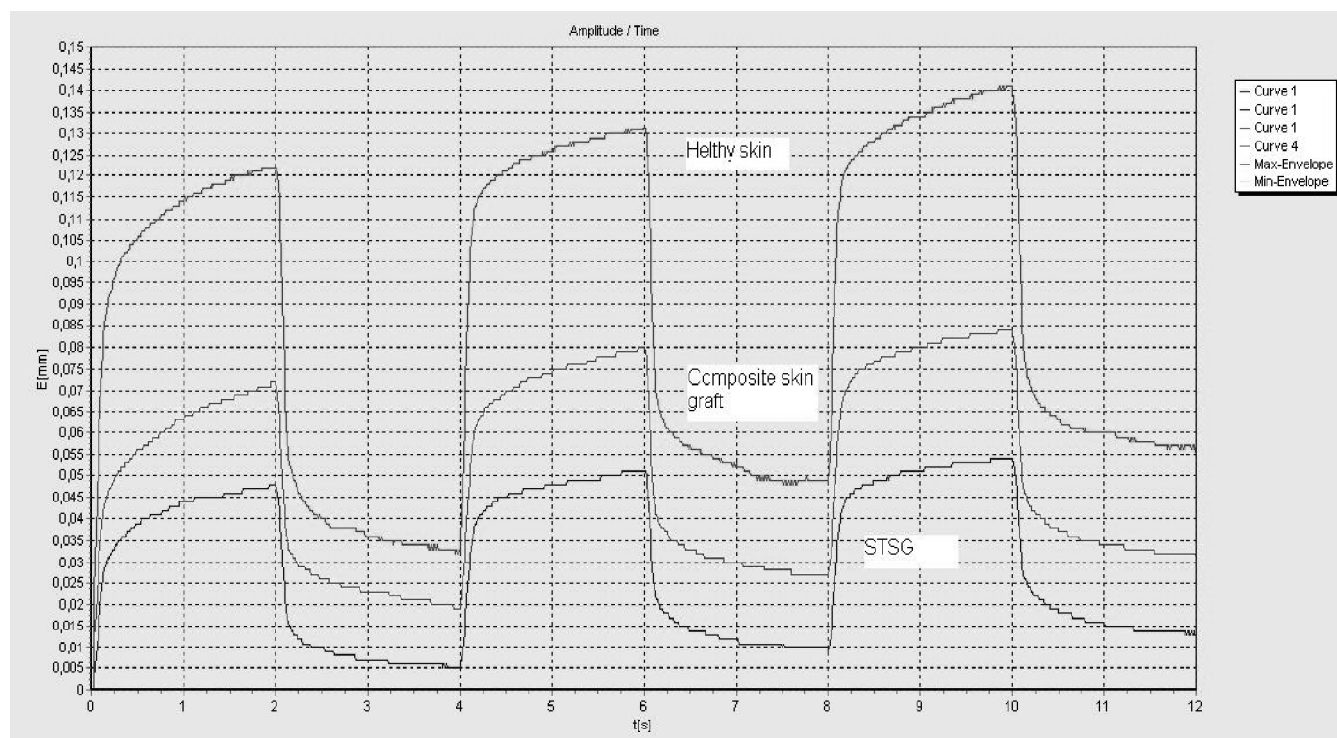


Fig. 9 - Cutometrical curves of healthy skin, composite skin graft, and split-thickness skin graft (STSG). The x-axis shows the time (sec) behaviour of the measurement. The y-axis shows the depth (mm) of skin penetration into the probe.

Vancouver Scar Score average values

Table I - Vancouver Scar Score one month after operation

	Pigmentation	Vascularity	Pliability	Height	Total
Dermoepidermal graft (STSG)	1	2	2	0	5
Allogeneic acellular dermis	1	1	1	0	3

Table II - Vancouver Scar Score six months after operation

	Pigmentation	Vascularity	Pliability	Height	Total
Dermoepidermal graft (STSG)	2	3	2	1	8
Allogeneic acellular dermis	2	2	0	1	5

Table III - Vancouver Scar Score four years after operation

	Pigmentation	Vascularity	Pliability	Height	Total
Dermoepidermal graft (STSG)	2	0	2	1	5
Allogeneic acellular dermis	1	0	1	1	3

thermal trauma in major joints where excessive scarring or other complications can be expected. We observed a very good take of the composite skin grafts even when the allogeneic dermis was slightly thicker (0.5-0.6 mm). The

thickness of the split-thickness skin graft seems to be more important (usually 0.15-0.25 mm). It should be added that it is necessary to immobilize the grafted area for at least six days to ensure the success of the procedure.

RÉSUMÉ. *Données générales.* Dans nos expériences préliminaires, nous avons constaté que les greffes cutanées composites constituées de derme acellulaire allogénique et de greffes autologues épidermiques minces appliquées dans la zone excisée de la brûlure dans une seule étape ont porté à de meilleurs résultats pour ce qui concerne les propriétés viscoélastiques par rapport aux greffes autologues de peau mince d'épaisseur variable. *Patients et méthodes.* Chez dix patients brûlés nous avons appliqué des greffes cutanées composites constituées de derme acellulaire allogénique et de greffes autologues épidermiques minces et nous avons observé la qualité de la couverture cutanée reconstruite utilisant un dispositif spécial, le Cutometer MPA 580, sur une période de quatre ans. *Résultats.* Les courbes cutométriques ont démontré de meilleures propriétés viscoélastiques dans les greffes cutanées composites par rapport aux greffes cutanées conventionnelles d'épaisseur variable mince après quatre ans. Nous avons trouvé que le Cutometer MPA 580 constitue un dispositif utile pour l'objectivation de l'amélioration de la qualité de la couverture cutanée reconstruite. *Discussion.* Parmi les diverses méthodes considérées le cutomètre a démontré l'avantage d'être une méthode non-invasive, précise et objective pour mesurer les propriétés viscoélastiques de la peau. Le Score Cicatriciel de Vancouver (Vancouver Scar Score) est une méthode d'évaluation subjective de la viscoélasticité de la peau. *Conclusion.* Notre étude prospective clinique a clairement démontré que le mesurage cutométrique a donné des résultats objectifs, contrairement à l'évaluation clinique, au Score Cicatriciel de Vancouver et à d'autres méthodes non-quantitatives. Nous avons donc obtenu la confirmation de notre hypothèse que les greffes cutanées composites constituées de derme acellulaire allogénique et de greffes autologues épidermiques minces appliquées dans la zone excisée de la brûlure dans une seule étape portent à de meilleurs résultats pour ce qui concerne les propriétés viscoélastiques par rapport aux greffes autologues de peau mince d'épaisseur variable.

Mots-clés: Cutometer MPA 580, évaluation cutométrique, greffes cutanées composites, derme acellulaire allogénique

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This paper was accepted on 24 September 2010.

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